

DISCIPLINE SPECIFIC CORE COURSE -4 (DSC-4) – : BIOCHEMISTRY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Biochemistry	4	3	-	1	Class XII pass with Physics, Chemistry and Biology as papers in Class XII.	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To effectively incorporate the fundamentals of metabolism through key biochemical pathways.
- Make the learners appreciate the requirement for the stringency of the regulation of these pathways.
- Introduce various biochemical techniques used in the characterization of the proteins.
- To give a detailed account on how enzymes function: their kinetics, regulation, and inhibition.

Learning outcomes

The Learning Outcomes of this course are as follows:

- By studying this course, students will be able to gain an understanding of fundamental biochemical principles of metabolism of biomolecules (Carbohydrates, Proteins, Lipids and Nucleic acids) and the associated bio-energetics. They will learn the biochemical reactions in metabolic pathways and understand their interrelations, logics, and patterns.
- By studying this course, students will be able to understand the role of enzymes in the biochemical reactions and the connection between biochemical defects and metabolic disorders. Students would additionally gather a firm understanding and relevance of stringent regulation of metabolic pathways.
- By studying this course, students will be able to learn how biological molecules (especially proteins) are characterized through various analytical techniques such as types of column chromatography methods, Polyacrylamide Gel Electrophoresis (PAGE) that are used in contemporary biochemistry research laboratories.
- By studying this course, students will be able to grasp the central concepts underlying enzyme catalysis, kinetics, and their mechanism of action. Effects of different kinds of enzyme-inhibitors will also be learned.
- By studying this course, students will be able to learn how coenzymes assist enzymes in catalyzing biochemical reactions and what is the criterion for their classification.
- By studying this course, students will be able to learn the general properties of regulatory enzymes, their activity and kinetics.

SYLLABUS OF DSC-4

UNIT – I (6.3 Weeks)

Metabolic pathways and their allosteric regulation

Carbohydrates- Glycolysis, Gluconeogenesis, Tricarboxylic acid cycle and their regulation, Cori cycle, Hexose monophosphate shunt.

Lipids- Mobilization of triglycerides, Metabolism of glycerol, Biosynthesis and β - oxidation of saturated fatty acids (palmitic acid) and their regulation. Significance of ketone bodies.

Proteins- General over view, Transamination, Deamination, Glucose-Alanine cycle, Urea cycle and its regulation.

Nucleic acid- General overview, an outline of purine and pyrimidine metabolism. Electron transport chain, Oxidative phosphorylation, and Substrate-level phosphorylation.

UNIT – II (2.3 Weeks)

Analytical methods in protein characterization

Introduction to spectrophotometry & Lambert-Beer's law, Column chromatography: Ion exchange chromatography, Gel filtration and Affinity chromatography, SDS-PAGE

UNIT – III (2 Weeks)

Enzymes

Introduction to enzymes, Concept of Lock & key and 'Induced fit theory, Concept of activation energy and binding energy. Enzyme kinetics: Michaelis-Menten equation and its physiological significance. Concept of enzyme inhibition: types of inhibitors (competitive & non-competitive) and their examples.

UNIT – IV (0.6 Weeks)

Coenzymes

Classification: various types and their function.

UNIT-V (0.6 Weeks)

Regulatory Enzymes

General properties of allosteric enzymes. Enzyme regulation by covalent modification. Zymogens.

Practical component

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Measurement of absorbance & %transmittance of a solution using spectrophotometer/colorimeter.
2. Preparation of standard plot and estimation of protein concentration by any one method: Biuret/Lowry/Bradford.
3. Estimation of glucose concentration by an enzymatic/non-enzymatic method.
4. Separation of biomolecules (sugar/amino acids) by thin-layer chromatography (TLC).
5. Separation of biomolecules by gel filtration/Calculation of void volume of Sephadex G-25 column, using Blue Dextran.
6. Analysis of SDS-PAGE as a separation technique (gel analysis).
7. To perform an assay of an enzyme under optimal conditions.
8. Determination of K_m , V_{max} and K_{cat} value of a given enzyme from the provided experimental data.

Essential/recommended readings:

- Nelson, D. L., & Cox, M. M. (2021). *Lehninger: Principles of Biochemistry* (8th ed.). Macmillan. ISBN:9781319322328
- Wilson and Walker's *Principles and Techniques of Biochemistry and Molecular Biology* (2018). 8th ed. Hofmann A. and Clokie S.(Eds.) Cambridge University Press, Cambridge, U.K.
- Plummer, D.T. (2012). *An Introduction to Practical Biochemistry*. New Delhi, India: McGraw-Hill College.
- S. K. Sawhney / Randhir Singh. (2009): *Introductory Practical Biochemistry*, Narosa Publishers, ISBN-13 : 978-8173193026
- Donald Voet, Judith G. Voet (2021) *Voet's Biochemistry, Adapted ed 2021*, ISBN: 9789354243820.

Suggestive readings:

- Berg, J., Gatto, G., Stryer, L. and Tymoczko, J. L. (2019). *Biochemistry*. New York, USA: W. H. Freeman and Company.
- Devlin, (2011). *Textbook of biochemistry with clinical correlations*. UK: Wiley T & Sons.

DISCIPLINE SPECIFIC CORE COURSE -5 (DSC-5) – : PRINCIPLES OF GENETICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Principles of Genetics	4	3	0	1	Class XII pass	Nil

Learning Objectives

The Learning Objectives of this course are as follows:

- The course intends to introduce students to Mendelian principles of inheritance, deviations from Mendelian inheritance and extra-nuclear inheritance.
- Introduction to pedigree analysis for autosomal and X-linked traits
- Understanding of differences between prokaryotic and eukaryotic genome organization, transposons, and basic cytogenetics.
- Understanding of mechanisms of sex determination.

Learning outcomes

The Learning Outcomes of this course are as follows:

- The flavour of genomics as a progression from Mendelian genetics will be introduced to the students. They will learn about classical experiments that led to discovery of the genetic material. They will also learn the structure of DNA.
- Students will be able to explain Mendelian laws of inheritance, deviations from monohybrid ratio (incomplete dominance, codominance, multiple alleles and lethal genes) and deviations from dihybrid ratio (gene-gene interactions, linkage). They must be able to distinguish sex-linked, sex-limited and sex-influenced traits. Students must also be able to interpret patterns of inheritance for autosomal and X-linked traits from pedigrees.
- Students would learn the concept of extra-nuclear inheritance.
- Students would learn the differences in genomes of prokaryotes and eukaryotes. They would also learn about transposable genetic elements with examples from prokaryotes and eukaryotes.
- The lectures will cover details of the structure of the chromosomes, the abnormalities that commonly occur at chromosomal level. Discussion of various types of mutations at the DNA level (deletion, addition, substitution), their consequence on gene structure/product and the diseases associated with these abnormalities.
- Students would gain insights into genetic and environmental sex determination mechanisms.

SYLLABUS OF DSC- 5

UNIT – I (01 Weeks)

Overview of Changing Paradigms in Genetics

A brief overview of how genetic principles took shape, leading to the concept of a blueprint of life within the cell to the physical entity of DNA. Basic structure of DNA, salient features of the double helix, semi-conservative replication– Meselson and Stahl experiment. Also mention the surprises we have from genomics such as genetic variation between individuals. There are popular videos/presentations that can be used. The purpose is to ignite the curiosity of the students.

UNIT – II (03 Weeks)

Concept of Genetic Inheritance

Concept of alleles, haploid and diploid status, phenotype and genotype, Mendel's laws of inheritance, dominant and recessive inheritance, test, back and reciprocal crosses with two examples each. Chromosomal theory of inheritance. Concept of linkage and crossing over, cytological proof of crossing over, genetic mapping: two and three-point cross over. Distinguishing recombination and complementation. Allelic interactions- dominance relationships- complete, incomplete and co-dominance, gene-gene interactions. Sex linked, sex-limited and sex-influenced traits. Gathering family history, pedigree symbols and construction of pedigrees for autosomal and sex linked traits (dominant and recessive).

UNIT – III (01 Weeks)

Extra Nuclear Inheritance

Criteria for extra nuclear inheritance, plastid inheritance in *Mirabilis jalapa*, kappa particles in *Paramecium*, maternal effect- snail shell coiling, cytoplasmic inheritance (mitochondria and chloroplast).

UNIT – IV (1.5 Weeks)

Genome Organization

Organization of Genomes in prokaryotes and eukaryotes. Establishing the Central Dogma. Nucleosomes organization and assembly. Euchromatin, heterochromatin- constitutive and facultative heterochromatin. Structure and significance of polytene and lampbrush chromosomes. Transposable genetic elements: Prokaryotic transposable elements- IS elements, Composite transposons; Eukaryotic transposable elements- Ac-Ds system in maize; Uses of transposons.

UNIT – V (1.5 Weeks)

Cytogenetics and Mutations

Chromosome: Structure- centromere and telomere, types of chromosomes based on centromere. Karyotyping- banding pattern and nomenclature (G and Q banding). Structural abnormalities (Duplication, Insertion, Deletion, Translocation-Reciprocal and Non-Reciprocal) and associated syndromes. Numerical abnormalities (Aneuploidy and Euploidy) and associated syndromes. Spontaneous and induced mutations. Types of mutations: Point (Non-sense, miss-sense, silent, frameshift, insertion, deletion). Effects on the Gene products- loss of function and gain of function.

UNIT – VI (01 Weeks)

Chromosomal theory of sex determination, mechanisms of sex determination, environmental factors and sex determination in human and *Drosophila*. Barr bodies and dosage compensation.

Practical component (8-10)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Observation of wild type and mutant phenotypes in *Drosophila*.
2. Preparation of culture media for *Drosophila* and study different stages of the life cycle of *Drosophila*.
3. Verification of Mendelian laws through *Drosophila*/ seeds – dominant, recessive and sex- linked
4. Study of Barr bodies.
5. Karyotyping with the help of photographs (normal and abnormal karyotypes).
6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
7. Study of diploidy in onion root tip.
8. Study of polyploidy in onion root tip by colchicine treatment.
9. Study of polytene chromosomes.

Essential/recommended readings

- Klug, W. S., Cummings, M., Spencer, C. A., Palladino, M. A., Darrell K. (2019). 12th Edition. *Concepts of genetics*. San Francisco, NY:Pearson ISBN-13: 9780134604718.
- Snustad, D.P. and Simmons, M.J. (2019). 7th Asia Edition. *Principles of genetics*. New York, USA: John Wiley and Sons. ISBN-13: 9781119657552.
- Gardner E. J., Simmons M. J. and Snustad D. P. (2006). 8th edition *Principles of genetics*. USA. Wiley. ISBN-13: 978-8126510436.

Suggestive readings

- Cooper, G. M. and Hausman, R. E. (2019). 8th Edition. *The cell: A molecular approach*. Massachusetts, USA: Sinauer Associates. ISBN-13: 978-1605358635.
- Hardin, J., Bertoni, G. P., Becker, W.M. (2017). 9th Edition. *Becker's world of the cell*. NY:Pearso. ISBN-13: 978- 0805393934.
- Karp, G., Iwasa, J., Marshall W. (2018). 8th Edition. *Karp's Cell Biology*. New Jersey, USA: Wiley. ISBN-13: 978-1119456292.
- Kornberg, A. (2005). 2nd Edition. *DNA replication*. California, USA: University Science Books. ISBN-13: 978-1891389443.
- Griffith A. J. F., Wessler S. R., Carroll S. B. and Doebley J. (2011). 9th edition. *Introduction to Genetic Analysis*. W H Freeman & Co. ISBN-13 : 978-0716768876.
- Elrod, S and Stansfield, W. (2010). 5th edition. *Schaum's Outline of Genetics*. McGraw Hill. ISBN-13: 978-0071625036.

DISCIPLINE SPECIFIC CORE COURSE -6 (DSC-6) HUMAN PHYSIOLOGY AND ANATOMY II

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Human Physiology and Anatomy II	4	3	-	1	Class XII pass with Physics, Chemistry and Biology as papers in Class XII.	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- The course curriculum is a systematic presentation of physiological concepts to ensure appropriate depth and breadth of basic functioning of the human body and its interrelations with respect to heart, lung, kidney, gonads, endocrine glands and digestive system.
- It would give students exposure of physiological concepts needed as foundations for further studies in pharmacology, pathology and pathophysiology etc.
- It would provide a base to understand body defenses and the mechanisms of deranged function of human body
- The curricular objectives are focused primarily on normal body function. Accordingly, wherever possible clinical examples have been illustrated to the underlying physiological principles.

Learning outcomes

The Learning Outcomes of this course are as follows: Having successfully completed this course, students shall be able to learn and appreciate:

- The students will learn appreciate the structure and functioning of heart, pattern and significance of blood flow in the blood vessels, heart sounds, ECG and purpose of lymph and lymphatic circulation.
- The students would correlate how structure and function of lungs are so intricately designed and how they function with its blood flow and help giving vital oxygen to body. They would develop understanding for neural control and other regulators of respiration and understand daily phenomenon like coughing, sneezing, yawning etc.
- Kidneys are vital organs and students would learn the functional anatomy of a nephron and how it contributes in removing the toxic waste from our body in form of urine. The curriculum would outline the process of micturition and abnormalities associated with it. It would also highlight the role of kidney in controlling pH of the body and preventing acidosis/alkalosis
- The students would have insight into the anatomy of the female and male reproductive systems, including their accessory structures. The student would understand the role of hypothalamic and pituitary hormones in reproductive system. Trace the route of a sperm mother cell from its production till it can fertilize an oocyte. Explain the events in the ovary prior to ovulation, development and maturation of the sex organs and the emergence of secondary sex characteristics during puberty.

- The students would be able to integrate the role of the endocrine system to maintain homeostasis in human body. Understand the chemical composition mechanisms of hormone action, their site of production, regulation, and effects of hormones of the pituitary, thyroid, parathyroid and adrenal, glands. Hormonal regulation of the reproductive system. The role of the pancreatic endocrine cells in the regulation of blood glucose In addition the contributions of hormones released by the heart, kidneys, and other organs with secondary endocrine functions. The student would be aware of several common diseases associated with endocrine system dysfunction.
- Students would be able to understand the organs of the alimentary canal from proximal to distal, and understand their function. Identify the accessory digestive organs and their functions. Describe the histology that is four fundamental tissue layers of the digestive tract. Contrast the contributions of the enteric and autonomic nervous systems to alimentary tract functioning. Gain awareness about common dysfunctions of digestive system like constipation, gastritis, ulcers, diarrhea etc.

SYLLABUS OF DSC-6:

Unit-I: Cardiovascular System (02 Weeks)

Functional Anatomy of heart, The Cardiac Cycle, Electrocardiogram. Circulatory system: Blood vessels, hemodynamics and regulatory mechanisms, Lymphatic circulation - hemodynamics and regulation, micro-circulation

Unit-II: Respiratory system (02 Weeks)

Functional Anatomy of the respiratory system. Mechanisms of pulmonary ventilation, alveolar ventilation, gaseous exchange, transport of gases, respiratory and nervous control and regulation of respiration

Unit-III: Renal Physiology (02 Weeks)

Body fluid and electrolytes: their balances and imbalances. Functional Anatomy of kidney, Histology of nephron and its physiology, Urine formation, renal regulation of urine volume and osmolarity, acid-base balance. Urinary bladder: structure, micturition and its regulation

Unit-IV: Reproductive System (02 Weeks)

Structure and function of male and female reproductive organ. Function and regulation of testicular and ovarian hormones. Gametogenesis (oogenesis and spermatogenesis), fertilization, implantation, parturition and lactation, menopause and basic concepts of infertility.

Unit V: Endocrine System (02 Weeks)

General mechanism of hormone action, Structure, function and regulation of the following glands and their secretions: Pituitary, Hypothalamus, Thyroid, Parathyroid, Adrenal, and Pancreas. Basic concepts about hypo and hyper secretion of hormones.

Unit VI: Gastrointestinal system (02 Weeks)

Anatomy and histology of digestive tract, gastrointestinal physiology: General principles of gut

motility secretion, digestion, absorption and assimilation. Gastrointestinal hormones: their formation and action. Physiological anatomy and functions of liver and pancreas.

Practical component

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Physiological data acquisition based experiments (ECG).
2. Physiological data acquisition-based experiments (EMG).
3. Physiological data acquisition-based experiments (PFT).
4. Blood Pressure recordings in humans.
5. Determination of specific gravity of blood.
6. Determination of osmotic fragility of RBC.
7. To study various types of contraceptives (condoms, IUD's, oral and injectable contraceptives)
8. To study different human organs and their sections through permanent slides. T. S. of thyroid, liver, thymus, spleen, ovary, artery, vein, capillaries, testis, pancreas, esophagus, adrenal, kidney (cortex and medulla), urinary bladder, urethra, fallopian tubes, epididymis, prostate glands, lungs, trachea, bronchioles, pituitary, heart. (Minimum 8 slides covering the systems mentioned in theory.)

Essential/recommended readings:

- Guyton and Hall Textbook of Medical Physiology, 14th edition (2020), J. E. Hall; W B Saunders and Company, ebook ISBN: 978-0-3236-4003-9; Hardcover ISBN: 978-0-3235-9712-8
- Human Physiology, 16th edition (2011), Stuart I. Fox; Tata McGraw Hill, ISBN10: 1260720462; ISBN13: 978-1-26-072046-4.
- Principles of Anatomy and Physiology, 16th edition (2020), Gerard J. Tortora and Bryan H. Derrickson; Wiley and Sons, ISBN: 978-1-119-66268-6. (e book), ISBN: 978-1-119-70438-6 (for print book).
- Textbook of Practical Physiology, 9th edition (2019), CL Ghai; Jaypee Publication, ISBN-9789352705320.
-

Suggestive readings:

- Ganong's Review of Medical physiology, 26th edition (2019), K. E. Barrett, S. M. Barman, S. Boitano and H. Brooks; Tata McGraw Hill, ISBN 978-1-26-012240-4 (for ebook) ISBN:978-1-26-012241-1 (for print Book)